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STATE OF UTAH
Division of Oil, Gas & Mining

# PLATEAU RESOURCES LIMITED
# TONY M MINE DEWATERING STUDY

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## INTRODUCTION

We have made this study of the dewatering of the Tony M Mine to assist in determining the suitability of the present dewatering system and to investigate and access alternative dewatering methods and water impoundment sites.

## FIELD WORK

We drilled a total of seven (7) boreholes during our field investigation for the Tony M Mine dewatering system. Three of these boreholes were drilled near the existing mine water retention ponds as shown in Figure 2. Two holes were drilled at the first alternate pond site investigated and also at the second alternate pond site investigated. The locations of the two alternate pond sites are shown in Figure 1 and a more detailed drawing of the second alternate site is shown in Figure 3. The logs for each of the sites are shown in Figures 4, 5, and 6.

## EXISTING POND SITE

At the site of the existing ponds, we found there to be clays and sandy clays of high plasticity over very dense claystones which readily break down to a high plasticity clay. We installed a slotted PVC pipe, open well piezometer in test boring 1 (TB-1) and in test boring 3 (TB-3) for monitoring the phreatic surface near the ponds and downstream of the ponds. During our investigation of this site we did not find evidence of the ponds leaking and we do not consider it probable at their current operation levels. At the time of our drilling we found no water downstream of the ponds in test boring 3, however, water was found in the first two borings.

Due to the extremely low permeabilities of the soils at test bore 1, a steady state condition did not exist within the piezometer during the days we were at the site, however, test bore 2 became very wet during its drilling indicating the existence of soils of higher permeability at that location.

Test bore 3 (TB-3) was located at the extreme east edge of the earthwork, which was done at this site, in order to determine the continuity of the subsurface soils. Sandy clays and gravels were found from the surface to a depth of approximately 6 feet with claystone below and extending the full depth of our bore hole.

Alternate Site No. 1

The second site which we inspected and drilled was an area of about 15 acres in size which is located about 500 feet northeast of the present temporary pond site. This site is a small valley area which is fairly isolated from outside surface drainage. From the two holes which we drilled at the site we found that Salt Wash sandstones underlie the entire surface area. The sandstone is exposed near the lower areas of the dam site, including the area which would be used for the dam site. The upper areas of the valley are covered with a shallow layer of fine silty and clayey sands. We found that the Salt Wash sandstone was quite permeable where we drilled at this site, however, we were not able to predict what possible infiltration capacity the site may have due to the lack of additional information which would include depths of the permeable sandstone member, lateral boundary conditions, and permeabilities of sandstones in areas of the site other than where we tested.

Alternate Site No. 2

The third and last site which we inspected and drilled was a very large area on the order of 100 to 200 acres which is located about 2000 feet south of the present temporary pond site. This site lies entirely within the Brushy Basin Member of the Morrison Formation which is composed of bentonitic claystones of very low permeabilities.

We drilled two holes at this site in an area which appeared to be a likely location for a dam site. Our drill holes were located within the drainage channel of the valley in order to determine the depth to the in-place soils and rock within this channel. We found there to be from 2½ to 3 feet of silty and clayey gravel alluvium over claystone and sandy claystone.

## LABORATORY TESTING

We tested the samples of soil obtained from our drilling at the second alternate site to determine its permeability and to also classify it as a soil. We used a falling head permeameter to determine the permeability of two samples of the mudstone. The samples for the permeability test were crushed at the natural moisture content to a -10 sieve size and then compacted and placed into the permeameter apparatus. Each sample was then compressed under a 5000 psf confining load and wetted and allowed to come to equilibrium prior to the application of the hydraulic head used during the test.

The results of the tests indicate a permeability of $1.6 \times 10^{-7}$ cm/sec for the dark rusty colored claystone collected at a depth of 19 feet in test bore 1 of alternate site number 2 and $6.7 \times 10^{-8}$ cm/sec for the grey colored sandy claystone collected at a depth of 15 feet in test bore 2 of the same site. Dry densities for the above samples as tested were 93.7 pcf and 110.6 pcf, respectively. Additional test results are given in Table 1 at the end of this report.

## RECOMMENDATIONS AND CONCLUSIONS

We have been advised by Plateau Resources personnel that the water being pumped from the mine will require treatment prior to discharge. Of all the acceptable alternatives for the treatment and disposal of this water, we believe that using evaporation ponds to totally evaporate all of the discharged water would entail the least risk of polluting the waters of the state and would be the most economically feasible. Other alternatives which were considered are discussed later in this report.

## PROPOSED CONCEPT TO PROCEED

We propose that the large valley which lies approximately 2000 feet south of the present mine water disposal ponds be further studied and a design for a large evaporation pond within this valley be developed. The pond should be of sufficient size to allow the total evaporation of all mine water which may be disposed of into it.

The design of this structure should be based on the maximum projected flow of mine water and surface runoff based on hydrologic studies. Further, if necessary, the pond must have an adequate storage capacity to enable it to store water which may not evaporate during cold periods of the year when evaporation rates are low.

Evaporation figures for Lake Powell obtained from the Department of Interior, Water and Power Resources Service indicate an average net annual evaporation rate of 48.0 inches plus or minus 10 inches with January having the lowest evaporation rate during the year of 3.2 inches for the month. Assuming that an evaporation pond with an area of 100 acres is used, and using the figure of 3.2 inches of evaporation per month for safety, the pond could evaporate about 198 gallons per minute.

We anticipate the design time for such a structure to be a minimum of 90 days and a maximum of 120 days providing materials are reviewed in a timely fashion by the owner and the reviewing agencies. This figure is based on the amount of time required to do the design work after all of the contouring information has been received.

Construction time for this project, which would be that time necessary to construct the dam and any other earth structures, is unknown at this time due to the lack of required information such as the location of the dam and amount of earthwork required, as well as the amount of earth moving equipment available for this project. Typically, with favorable conditions, a 651 scraper, using double D9 pushers, with an average haul distance of 1000 yards can transport on the order of 270 cubic yards per hour. Therefore, five scrapers operating under similar conditions could conceivably transport 1350 cubic yards per hour.

Once the evaporation pond has been constructed and is in use, an inspection and maintenance program should be enacted. The dam should be regularly inspected for leakage and any unusual conditions. Also, a monitoring sytem should be designed based on the final dam design and location and should be checked regularly to determine the pond's effects on the groundwater in the area.

Provisions for the cleaning of the pond should, if possible, be incorporated into the original design. These provisions would possibly include the ability to partition parts of the pond for draining such that the drained area could be cleaned while the pond still functioned. Further, equipment access should be provided where needed to allow for cleaning and maintenance. Cleaning and maintenance will include the control of unwanted vegetation and plant growth as well as the removal of sediments if required.

Reclamation of the site will be required when it is no longer in use. Methods of reclaiming this area are varied, however, basically the toxic materials should either be removed or buried. To assure that the waters of the state are not polluted and to avoid the necessity of ongoing monitoring and maintenance, it would probably be necessary to remove the deposited toxic materials from the site.

Assuming that an evaporation pond of 100 acres in surface area is necessary and, therefore capable of disposing of approximately 200 gpm throughout the year, the time which would be required to deposit sediments to a depth of 1 foot over the entire area would be about 355 years. This figure is based on sediments with a dry density of 85 pounds per cubic foot and mine water with 4.5 grams/liter of TDS.

The degree of toxicity of the sediments based on the materials at hand are beyond the present scope of this study.

## ALTERNATIVE DISPOSAL METHODS

Also considered during this study were other various methods of disposal as discussed below. These methods, although usable, did not afford the safety and feasibility possible with the method of total evaporation.

### 1. Injection Into Mine Aquifer

This method involves the use of drill holes to transport the water from the mine back into the aquifer from which it originated or to another suitable aquifer. It would involve deep monitoring systems and settlement ponds for removal of any particles within the water prior to its injection.

Due to the probable low transmisivity of the aquifer and the complexity and expense of this type system, this method was considered impractical. Further, due to the conditions of the water to be injected and the aquifer, the system may plug or become greatly impaired after prolonged use.

## 2. Infiltration Into Upper Subsoils

This method would incorporate the use of a large pond with a permeable bottom to allow water to infiltrate into the surrounding soil and rock while at the same time water would evaporate from the ponds surface. This method would require the construction of a dam in an area of high permeability and would require a system to monitor the ground-water caused by this sytem.

Although this sytem is practical in some respects, to be assured that such a system will work to design capacity a large amount of research into the site must be performed. The alternate site number 1 which we inspected could possibly be used for such a system, however, the cost and time required to determine its infiltration capacity plus the possibility that the system would fail to provide for the disposal of the projected water quantities made it impractical to pursue.

## 3. Treatment To Remove Pollutants

This method involves chemically treating the mine water to reduce the pollutants. Treated water could then be discharged directly or could be injected or infiltrated for final disposal. The system would require two ponds, one pond for settlement of the water prior to treatment and a pond for settlement of the water after treatment and prior to discharge.

This method would probably be much more expensive than other methods due to the expense of buying and operating the equipment. Also, the ponds would have to be quite large for adequate settling and storage should the equipment fail. Direct discharge after treatment would call for continual monitoring and infiltration or injection would require the added expense of another complete system.

ARMSTRONG ENGINEERS AND ASSOCIATES, INC.

Byron W. Kelly

By: Byron W. Kelly
Geotechnical Engineer

Approved By:

Edward A. Armstrong

Edward A. Armstrong, PE-LS
President

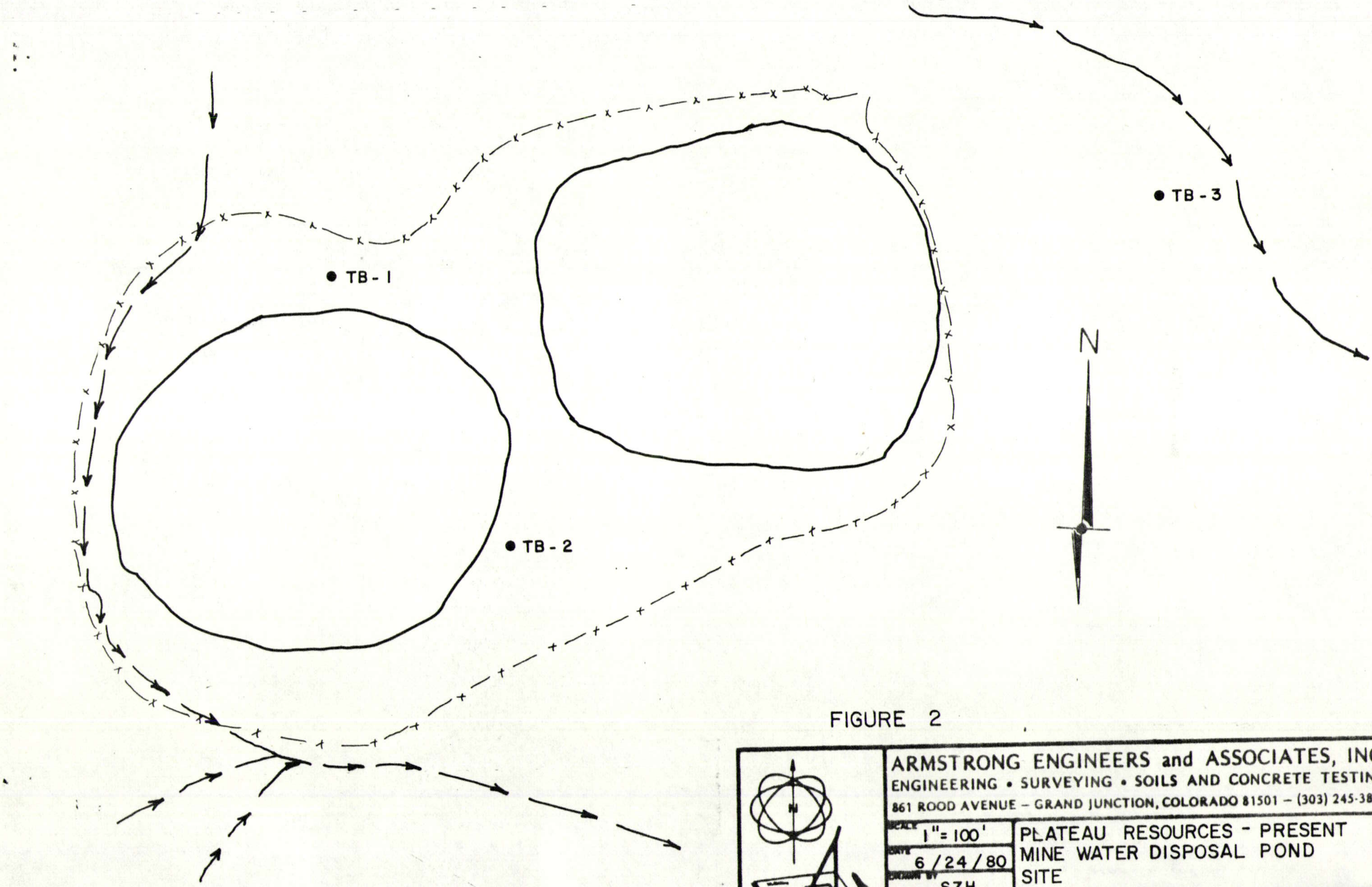


FIGURE 2

| | |
|---|---|
| ARMSTRONG ENGINEERS and ASSOCIATES, INC. ENGINEERING • SURVEYING • SOILS AND CONCRETE TESTING 861 ROOD AVENUE – GRAND JUNCTION, COLORADO 81501 – (303) 245-3861 | |
| SCALE 1" = 100' | PLATEAU RESOURCES - PRESENT MINE WATER DISPOSAL POND SITE |
| DATE 6/24/80 | |
| DRAWN BY SZH | |
| CHECKED BY BWK | SHEET 2 of 7 |
| DATE OF SURVEY 06/80 | JOB NUMBER 802873 |

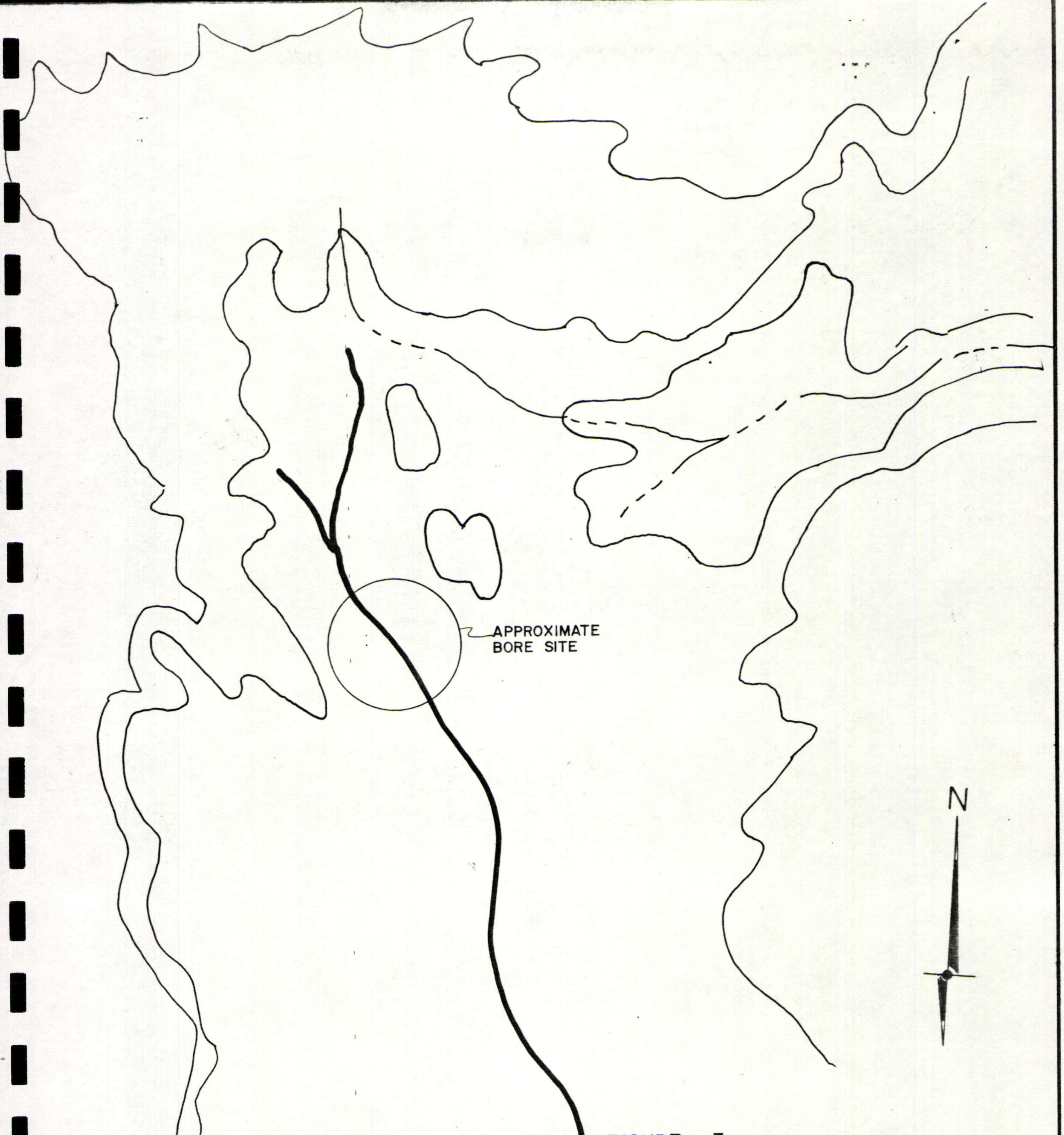


FIGURE 3

**ARMSTRONG ENGINEERS and ASSOCIATES, INC.**
ENGINEERING • SURVEYING • SOILS AND CONCRETE TESTING
861 ROOD AVENUE – GRAND JUNCTION, COLORADO 81501 – (303) 245-3861

| | | |
|---|---|---|
| SCALE N.T.S. | PLATEAU RESOURCES ALTERNATE SITE NO. 2 | |
| DATE 6/25/80 | | |
| DRAWN BY JMT | | |
| CHECKED BY BWK | SHEET 3 of 7 | JOB NUMBER 802873 |
| DATE OF SURVEY 6/12/80 | | |

Topsoil

Asphalt w/ Base Course

Fill (Non-specific)

Clay

Silt

Sand

Gravel

Cobbles

Boulders

Weathered Zone

Siltstone

Claystone

Shale (Interbedded Sandstones, Siltstones and Claystones).

Sandstone

Limestone

Very hard igneous or Metamorphic rock, i.e.; Granite, Schist, Gneiss, Quartz, etc.

Concrete

Undisturbed Shelby Tube Sample

2 inch diameter Drive Sample (The Symbol 4/12 indicates that 4 blows of a 140 lb. hammer falling 30 inches were required to drive Sampler 12 inches.

220 Indicates that a permeability of 220 feet/year was determined for the interval shown.

COMBINED SYMBOLS INDICATE THAT THE SOIL IS COMPOSED OF MORE THAN ONE SOIL TYPE.

EXAMPLES:

Silty Sandy Gravel (Note the greater concentration of the gravel symbol)

Silty Clay (Note the greater concentration of the clay symbol)

Clayey Sand (Note the greater concentration of the sand symbol)

Practical Rig Refusal

5 Water Table and number of Days after Drilling

C Hole caved in at depth indicated

FIGURE No. 7

ARMSTRONG ENGINEERS

ENGINEERING – SURVEYING

CONCRETE & SOILS TESTING

Soils Legend & Notes

JOB NO. 802873

# ARMSTRONG ENGINEERS AND ASSOCIATES

## TABLE 1

## SUMMARY OF LABORATORY TEST RESULTS

| HOLE | DEPTH (FEET) | NATURAL MOISTURE (%) | NATURAL DRY DENSITY (PCF) | ATTERBERG LIMITS | | UNCONFINED COMPRESSIVE STRENGTH (PSF) | DIRECT SHEAR TESTS QUICK, UNDRAINED | | % PASS. #200 SIEVE | SOIL TYPE | STD. PENT. TEST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | | Ø | COHESION C | | | |
| TB-1 | 4 | | | 72 | 29.5 | | | | 86.5 | | 60 |
| TB-2 | 9 | | | 52.8 | 34 | | | | | | 60 |

This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number M0170001 Mine Name Tickaboo Stockpile
Operator UCOLO Expl. Corp Date 9-12-1980
TO ____ FROM ____

__CONFIDENTIAL __BOND CLOSURE __LARGE MAPS X EXPANDABLE
__MULTIPUL DOCUMENT TRACKING SHEET __NEW APPROVED NOI
__AMENDMENT _OTHER ____

Description YEAR-Record Number

__NOI X Incoming __Outgoing __Internal __Superceded

Plateau Resources Limited
Tony M. Mine Dewatering Study

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__TEXT/ 81/2 X 11 MAP PAGES __11 X 17 MAPS __LARGE MAP

COMMENTS: ____

CC: ____